STUDENTS’ PERCEPTIONS OF PRACTICE PRACTICALS: AN APPROACH TO ACTIVE LEARNING

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Introduction
The module LSM3225 “Molecular Microbiology for Human Diseases” introduces undergraduate students to the molecular principles and physiological processes involved in the life cycle of microbes (virus, bacteria, fungi and parasites) in relation to how these microbes affect human health and diseases. Great emphasis is placed on the practical application of advanced molecular technologies in the identification, treatment and prevention of both existing and newly emerged microbial pathogens.

Limitations of traditional practical sessions
Most of the traditional practical sessions offered in the undergraduate life sciences modules are designed such that to complete the experiments, students are only required to follow the instructions (step-by-step protocol) provided during the session itself. There are a few pedagogical drawbacks with such a step-by-step approach. For one thing, students neither have the chance to plan and think in depth about their experiments, nor are they able to exercise their creativity during the practical session. Such an approach provides limited opportunities for students to think about the problem associated with the practical and to adopt a proper experimental approach to formulate a solution. In short, they may not know how to apply the skills they learnt in the practical session to solve a real-life problem. As a consequence, it is common during the semester feedback exercise to observe students leaving comments that they find the traditional practical sessions boring, non-challenging and leave no room for them to be creative when it comes to applying these practical skills.

Introducing Practice Practicals
In order to address these issues in LSM3225, I introduced the concept of “Practice Practicals” for one of the topics during the module’s practical sessions. The term Practice Practicals simply means that
students acquire technical knowledge and skills through the process of formulating and executing their experiments independently. Practice Practicals aim to give students the opportunity to participate actively in formulating their experiments in order to develop the ability to solve a real-life problem. The concept of Practice Practicals is based on active learning, a model of instruction which aims to engage learners in two ways: doing things and thinking about the things they are doing (Bonwell & Eison, 1991). It is hoped that through active learning, learners will engage in higher-order thinking tasks such as analysis, synthesis, and evaluation (Renkl, Atkinson, Maier & Staley, 2002).

The objective of the practical session, which adopts the Practice Practical approach, is for students to attempt to develop a rapid and reliable real-time polymerase chain reaction (RT-PCR) diagnostic assay¹ based on an SYBR Green DNA dye-binding fluorophore² that detects the mosquito-borne Chikungunya virus. It is hoped that by the end of the practical sessions, students will be able to achieve the following learning outcomes:

- acquire practical competence and accuracy in formulating, planning and carrying out experimental procedures including measurement, use of apparatus/equipment (logistics) and recording of results
- write a clear scientific report which should include the theoretical background, experimental description, presentation and analysis of results, as well as an interpretation and evaluation of the experiment
- communicate the data they obtained from the experiments effectively.

Implementation

Two different cohorts of undergraduate students (n=240) participated in this study, which was conducted over two academic years, from AY2011/12 to AY2012/13.

The implementation of this approach began with giving students some initial guidance on the objective of the experiments, in the form of a list of guiding questions given during the first practical session. These questions (see Table 1) would help to facilitate students' to think in greater depth about their experiments for the practical session.

<table>
<thead>
<tr>
<th>Critical Thinking Questions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Why do we need to have early diagnosis of Chikungunya virus infection in patients?</td>
</tr>
<tr>
<td>What are the current diagnostics technologies for viral pathogen detection? What are the advantages and disadvantages of the specific diagnostic technology that you could recall?</td>
</tr>
<tr>
<td>Why do we use SYBR Green DNA dye as the detection system for this RT-PCR diagnostic assay?</td>
</tr>
<tr>
<td>Can you brainstorm on the materials and resources that we will need to set up this molecular diagnostic assay as stated in our learning objective.</td>
</tr>
</tbody>
</table>

Table 1. List of guiding questions to help students think about the objectives of performing the experiments.

The students were then placed in groups of 8. Each group had to formulate the experimental protocol and come up with a list of infrastructures (reagents, equipment and other materials) to support their experimental approaches. More importantly, the groups had to present their ideas in front of the whole class. During the discussion session, we observed active class participation and engagement from the
students as the different groups presented their diverse experimental approaches. We then translated the best idea presented into actual practice for the rest of the class.

The following flowchart (Figure 1) provides a summary of how the Practice Practical session (“Practical 1” in the flowchart) was implemented:

![Flowchart of Practice Practical session](image)

**Figure 1. Flow chart of the Practice Practical session.**

**Survey Findings**

An evaluation of the effectiveness of Practice Practical session was done through a short survey (see Figure 2 for a sample) which students had to complete after they had submitted their laboratory reports for assessment and grading. They had to indicate their level of agreement to a series of statements on a 5-point scale, ranging from “Strongly Agree” to “Strongly Disagree”. The survey form also included two short questions in which students had to give their comments about the strengths of the Practice Practical session and possible areas of improvement.

200 students (83% of the total student cohort from both academic years) responded to the survey. The following are key findings based on an analysis of the survey results:

**The Practice Practical session was interesting and students felt comfortable sharing their ideas**

According to the survey results, 66% of the respondents agreed that the Practice Practical session (“Practical 1” in the survey) was interesting and stimulating. This is an encouraging response as students can be shy when it comes to participating in class discussions or sharing their ideas (Shim, 2006). However, in this case, only 1.5% of the respondents indicated that they felt uncomfortable about sharing their thoughts and opinions during the discussion portion of the practical. Indeed, I noted active class participation amongst students during the group discussions. Students also recognised the benefits of having these discussions during the practical:

- “We rarely get to voice out our thoughts and opinions during practical classes, and this was a good way to stimulate us to think more about the practical. I have enjoyed this approach of conducting real-life experiments!”
Feedback Form
LSM3225 Molecular Microbiology in Human Diseases

Practical 1: One-Step Real-Time PCR Detection and Quantification of Chikungunya virus

Please use the following five point scale to respond to the following questions. Please tick in the appropriate option.

<table>
<thead>
<tr>
<th>Feedback</th>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formulating the experimental approaches for Practical 1 is interesting.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☑</td>
</tr>
<tr>
<td>Formulating the experimental approaches for Practical 1 is challenging.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☑</td>
</tr>
<tr>
<td>I feel comfortable sharing my opinions, questions and ideas during the discussion session of this practical.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☑</td>
</tr>
<tr>
<td>I find that this practical stimulates my interest in reading more about the topics and technologies.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☑</td>
</tr>
<tr>
<td>This practical has enabled me to learn and acquire the necessary experience and skills to formulate experiments to solve scientific questions.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☑</td>
</tr>
<tr>
<td>I am competent in the technical aspects of diagnostic RT-PCR after practical 1.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☑</td>
</tr>
<tr>
<td>I am competent in the interpretation and analysis of the RT-PCR data after practical 1.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☑</td>
</tr>
<tr>
<td>Overall, practical 1 was useful in enhancing research and technical skills.</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☐</td>
<td>☑</td>
</tr>
</tbody>
</table>

Please comment on the strengths of Practical 1 and the way it was conducted?

________________________________________________________________________

________________________________________________________________________

Please comment on the areas that Practical 1 may be improved upon.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Thank you for your feedback. This will help us to improve the quality of the module.

Figure 2. Sample of the survey form.
The Practice Practical session stimulated students’ interest in the subject matter

In addition, 72% of the respondents mentioned that the Practice Practical session helped stimulate their interest in the subject and it encouraged them to read more about the topics and the relevant technologies. For example, students mentioned in the qualitative feedback portion of the survey that they will read about the topic on the Internet before coming for the practical class. This response is a good indication that self-directed learning is taking place amongst students due to the session. According to Lim and Geertsema (2013), self-directed learning provides the learner with the opportunity to take the initiative and be responsible for the learning process. Some students also felt that the Practice Practical session encouraged them to think independently and in greater depth about how they were supposed to formulate their experimental approach:

• “I like the way we were asked to formulate the experiments before practical as it gives us the opportunity to research deeper into the topics.”
• “Students were encouraged to formulate the experiments which make it interactive (not-spoon feeding). It enhances students’ learning experiences.”
• “It wasn’t like the practical before that we are not given the opportunity to formulate our experimental approaches. This has definitely enhanced my learning of the topic.”
• “Encourages students to think about their experiments and do some research on the practical objectives.”

The Practice Practical session enhanced students’ independent research and technical skills

Furthermore, the majority of students (83%) mentioned that the approach was useful in enhancing their independent research and technical skills. Some also felt that they could apply the skills acquired during the practical session to real-life problems:

• “Practical is interesting and useful in enhancing my capability to perform research, especially in future career in research.”
• “It’s the first time since year 1 that I had such a detail and technical practical session. I thought it was really useful because RT-PCR is so widely used nowadays. I could apply the knowledge to other modules too.”
• “Something practical and real that is applicable to life examples, so it’s an eye-opener for me.”

Conclusion and the Way Forward

Based on the quantitative and qualitative feedback gathered, we can conclude that the majority of students responded positively to the concept of Practice Practicals, agreeing that the session they went through was interesting and stimulating. This approach was also useful in enhancing students’ research and technical skills. In addition, for future sessions with subsequent cohorts, I plan to incorporate a written component that involves getting students to write short reflective notes about their learning experience. However, while this approach is beneficial in enhancing students’ learning during practicals, more needs to be done to evaluate whether it is applicable for other Year 3 or Year 4 life sciences modules in the Department that are practical-intensive.
Acknowledgments

I would like to express my appreciation to A/P Too Heng-Phon for his helpful comments on this study and the staff of the CDTL for their support and mentorship.

Endnotes

1. A quantitative or qualitative test of a substance (especially an ore or a drug) to determine its components; frequently used to test for the presence or concentration of infectious agents or antibodies. (Source: http://www.vocabulary.com/dictionary/diagnostic%20assay)

2. It is a fluorescent dye used as a nucleic acid stain in molecular biology (Source: http://en.wikipedia.org/wiki/SYBR_Green_I)

About the Author

Dr Justin Chu currently teaches several life sciences modules and postgraduate modules related to microbiology, molecular microbiology and virology to life sciences undergraduate and postgraduate students at the Yong Loo Lin School of Medicine.

He believes in the importance of engaging students in an active learning process by which they can hone their critical thinking skills. He hopes that his student will see learning as a continuous process of self-discovery in which they will develop a deeper awareness and knowledge of their environment.

References


